MANGANESE AND COBALT INVESTIGATION OF THE KONGAKUT RIVER REGION

By D. D. Southworth and G. S. Will

Critical and Strategic Minerals in Alaska --

Eastern Brooks Range Project

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BUREAU OF MINES

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MANGANESE AND COBALT INVESTIGATION OF THE KONGAKUT RIVER REGION

By D. D. Southworth[1] and G. S. Will[2]

INTRODUCTION

A brief mineral investigation of a reported occurrence of manganese nodules in the Kongakut Formation of northeastern Alaska (fig. 1) was made by the Alaska Field Operations Center, U. S. Bureau of Mines. The work was part of an Alaska-wide assessment of 'critical and strategic' minerals, and it follows-up on the brief reports of visual mineralization by the U. S. Geological Survey.

The following manuscript is a summary of field work conducted in 1981 and will be updated if additional work is undertaken. The specific objective of this investigation was to evaluate the potential for economic concentrations of metals sometimes associated with deposits of manganese nodules, especially cobalt and copper. Since the area is virtually unexplored at the present time, the likelihood of discovering ore deposits with this scale of effort, even if they occur in the region, is remote. It is not the present intention of the Bureau to commit the necessary time and expenditures to discover and to determine grade and tonnage of mineral deposits in the region.

While only manganese nodules and minor copper and lead mineralization has been noted in the Kongakut River area, it was felt that

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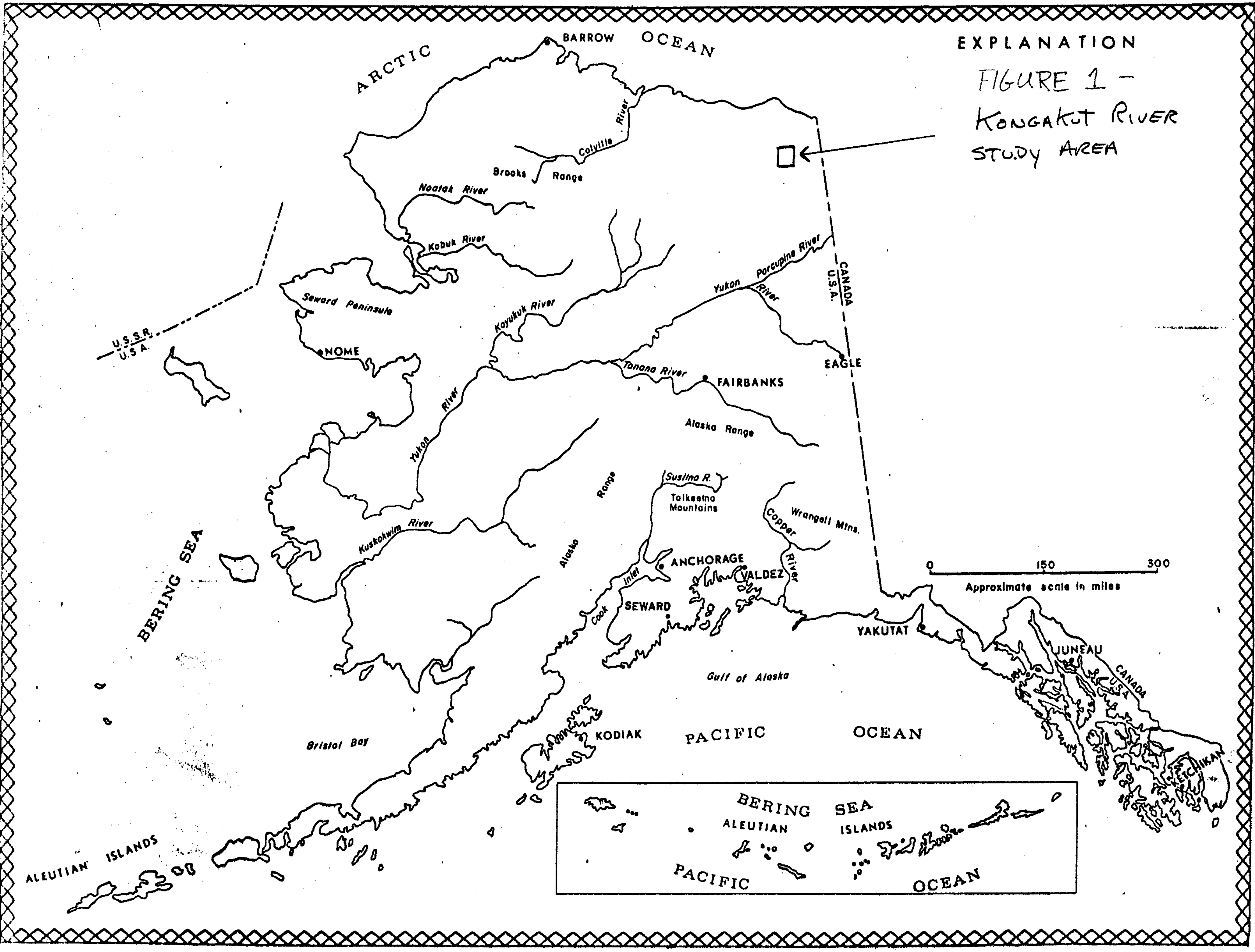
EXPLANATION
FIGURE 1 -
KONGAKUT RIVER
STUDY AREA
BARROW
ARCTIC
OCEAN
Colville River
Brooks Range
Noatak River
Kobuk River
Seward Peninsula
Koyukuk River
Yukon
Porcupine River
River
CANADA
U.S.A.
U.S.S.R.
U.S.A.
NOME
EAGLE
Tanana River
FAIRBANKS
Yukon River
Alaska Range
Range
Susitna R.
Talkeetna Mountains
Wrangell Mtns.
Copper River
Kuskokwim River
Alaska
BERING SEA
ANCHORAGE
VALDEZ
0
150
300
Approximate scale in miles
Cook Inlet
SEWARD
YAKUTAT
JUNEAU
CANADA
USA
Gulf of Alaska
KODIAK
PACIFIC
OCEAN
Bristol Bay
KETCHIKAN
BERING SEA
ALEUTIAN
ISLANDS
PACIFIC
OCEAN
ALEUTIAN ISLANDS

FIGURE 1.

the geological setting may be favorable for an association of cobalt mineralization. There has been no attempt in the past to evaluate cobalt in the eastern Brooks Range. Presumably an investigation of the geology and possibly the mineralization of the Kongakut area would further serve as an example of a much more widespread geologic terrane in the eastern Brooks Range. The area examined covers approximately 40 sq mi of rugged mountainous terrain in the eastern Brooks Range.

HISTORY AND PREVIOUS INVESTIGATINS

There has been no known mineral exploration of the Kongakut River region. Undoubtedly some gold prospectors visited the region after the Alaskan gold strikes of the early part of the century, however there were no reports of gold discoveries. At that time, minerals other than precious metals were of no economic interest in such a remote area as northeastern Alaska.

Early work by the U. S. Geological Survey included regional reconnaissance by Leffingwell in 1919 (7).[3] Gryc, Patton and Payne (3) described and named the Okpikruak Formation about 320 km (200 mi) to the west of the report area. Keller, Morris and Detterman (5) extended that formation into northeastern Alaska.

Field investigations by Detterman, Reiser, Brosge and Dutro (2) defined the Kongakut Formation based on differences in lithology of the rocks exposed along Bathtub Ridge (fig. 2) and similar age (Neocomian)

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[3] Underlined numbers in parentheses refer to items in the list of references at the end of this report.

FIGURE 2 - Geologic and topographic map of Drain Creek

Topographic base is Table Mtn. & Demarcation Point Quadrangles (1:250,000) rocks of the Okpikruak Formation. It was Detterman, et al. (2) who first reported the occurrence of manganese-rich beds, manganese nodules, and "small amounts" of lead and copper of unspecified mineralogy in the shales of the Kongakut Formation. Geological reconnaissance mapping at 1:250,000 scale was compiled by Reiser and others (8). Other Geological Survey investigators, too numerous to list here, have compiled regional studies pertaining to various aspects of geology, geomorphology and geophysics of the eastern Brooks Range. Their work is listed in the publication files of that agency.

OWNERSHIP

The entire area of this investigation is included within the Arctic National Wildlife Range which was established by Public Land Order 2214 on December 6, 1960. As part of the Alaska Land legislation of December 2, 1980, (PL 96-487) this area was also given a "Wilderness" classification. The area is administered by the National Fish and Wildlife Service, U. S. Department of Interior from their field office in Fairbanks.

PHYSIOGRAPHY AND CLIMATE

The report area is within the Romanzof Mountains of the northeastern Brooks Range, and lies immediately north of the continental divide (fig. 1).

Drain Creek and Cottonwood Creeks are southeasterly flowing tributaries to the Kongakut River. Here the valley of the Kongakut serves to separate the Romanzof, British, and Davidson mountain ranges. Flood plain sediments of the Kongakut consist of former till and of material reduced by mechanical fracturing and abrasion. The primary river channel is quite braided and occupies a former glacial valley. The secondary creek drainages, such as those of Drain and Cottonwood Creeks, are somewhat steeper, vary in width from 4 to 15 ft and are gravel bottomed. The valley floor of the report area (see figure 2) has an altitude of approximately 2000 ft. The highest point on Bathtub Ridge is at about 6000 ft above sea level.

Climate is arctic alpine, with low precipitation levels. Extended periods of mist, wind, and light drizzle, however, are typical in the summer. The snow free period generally extends from mid-June to early September, although snow can occur in any month of the year.

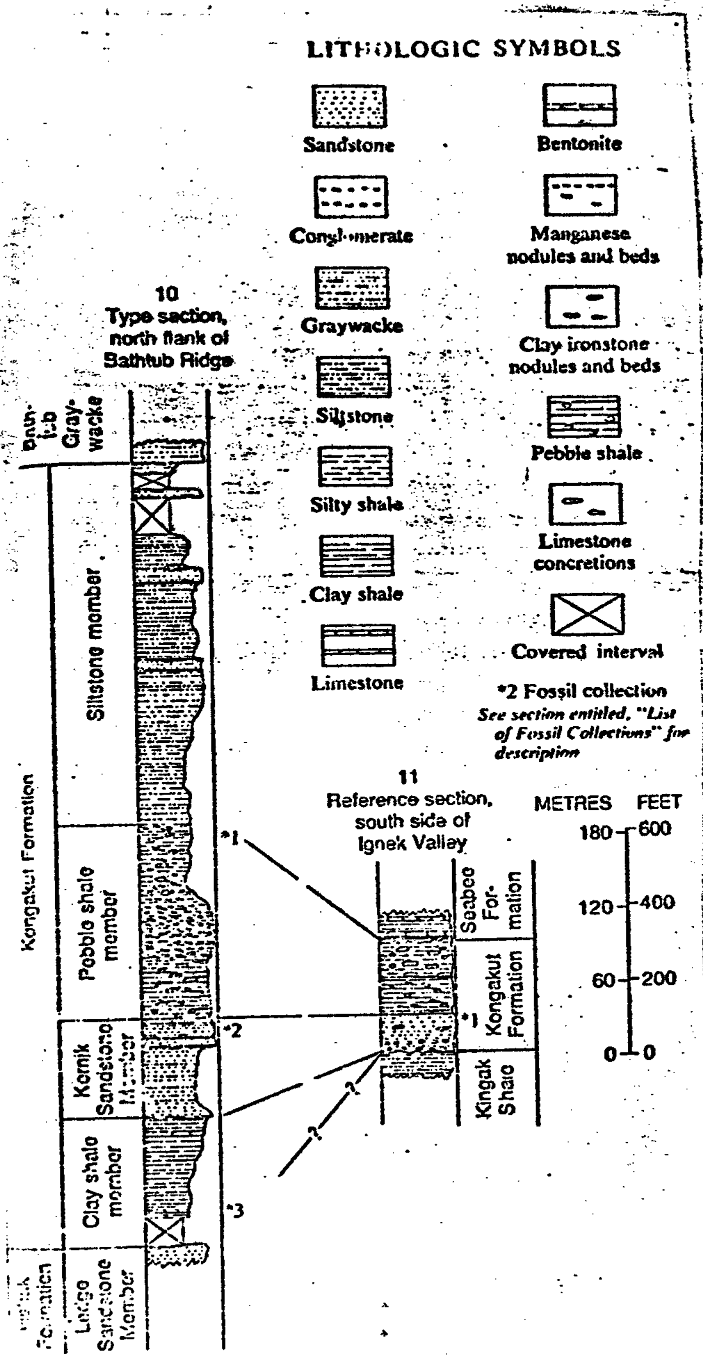
Vegetation is sparse, consisting of spongy bogs and tundra on the valley floors and on moderately inclined slopes. Stunted growths of willow and alder brush are found in protected ravines at lower elevations. A few areas in the upper reaches of Drain Creek support growths of poplar, however, which attain diameters of up to a foot or more. Rock exposure is good along the creeks, especially in the more resistant shale units, which could also be viewed along the ridges. Due to the arctic climate and active erosion there is very little soil development by normal chemical processes.

ACCESS

Access to the report area is limited to air during the summer. Small wheeled aircraft (e.g., a Cessna 185) can land on an unimproved gravel-bar landing strip on the Kongakut River (location shown on fig. 2). Operation of helicopters, though practical in this terrain, is prohibited due to the present land classification. The village of Kaktovik at Barter Island, approximately 80 mi to the northwest of the study area, is the most practical logistical center. Communications, lodging, supplies and charter aircraft are available there. Bush plane operation on VFR is most reliable from Kaktovik since the continental divide to the south is frequently obscure, thus blocking access from more southern bush villages.

REGIONAL GEOLOGY

The geologic setting of the report area is dominated by Bathtub Ridge, a prominent feature running generally east-west. It is approximately 20 mi in length and is an average of 3 mi in width. The lowermost geologic unit of the report area is the Ivishak Formation (Lower Triassic) of the Sadlerochit Group (Upper Permian to Middle Triassic in age) which is unconformably overlain by the Kongakut Formation (fig. 3). The Kongakut Formation is a thick Lower Cretaceous shale and siltstone sequence that contains a sandstone unit near the base (2). At its type area on the north flank of Bathtub Ridge, the Kongakut Formation has been divided by Detterman and others (2) into three informal members and one formal member. Stratigraphically from bottom to top these are: the clay shale member, the Kemik Sandstone member, the pebble shale member, and the siltstone member. North of the Brooks Range, the Kongakut Formation locally contains several unconformities; in most areas the clay shale member is missing and the Kemik Sandstone member is the basal unit of the formation. Locally, the pebble shale member cuts out both the Kemik Sandstone and underlying clay shale and rests unconformably on rocks from the Jurassic Kingak Shale to the Ivishak Formation of Lower Trassic age. This latter is probably the major Early Cretaceous unconformity in northern Alaska. Disconformably overlying the Kongakut Formation in



–Type and reference sections for the Kongakut Formation.

FIGURE 3 - Stratigraphic column of the Kongakut formation type-section (FROM DETTERMAN, et al., 1975)(2)

the study area is the Bathtub Graywacke (2), a thick sequence of graywacke and conglomerate of probable early Albian age.

The pebble shale member of the Kongakut Formation is about 520 ft thick and is reported to contain approximately 175 ft of highly manganiferous (5% Mn) beds, along with small amounts of lead and copper. Also found throughout this unit are flattened, highly polished chert pebbles as much as 2.5 cm (1 in) in diameter and a few well-rounded quartz grains 0.03 to 0.05 mm in diameter. Clay ironstone nodules are common throughout this unit, except in the manganiferous horizons. Lack of faunal evidence, coupled with the presence of manganese nodules, suggests deepwater deposition for this member, although the evidence is not conclusive. The overlying siltstone member would then represent a return to shallow-water conditions (2).

WORK BY THE BUREAU

FIELD WORK

A brief investigation of the upper Kongakut River and Drain Creek region was made in July, 1981. Work was conducted by a two-man team working on foot from a tent camp on Drain Creek approximately 12 mi from an unimproved landing strip on the Kongakut River. A total of five days were spent working the area which included mapping, geochemical sampling and examination of mineralized exposures and float. This included an abortive attempt to reach the type-section of the Kongakut Formation which had previously been reported to contain manganese nodules and lead and copper sulfides (?)(2). Due to foul weather, time limitations and the distances involved, the attempt was abandoned at the divide between Drain and Cottonwood Creeks.

SAMPLING AND ANALYTICAL PROCEDURES

Stream sediment samples (table 1 and fig. 4) were collected by hand or with a steel shovel from the finer sandy portion of the active channel or deepest most active part of a dry creek bed. Organic-rich material was avoided. Samples were put in water resistant paper sample bags and air-dried before screening at -80 mesh. Float-rock and stream characteristics were noted and recorded at each sample location.

Rock samples were usually taken as random chip samples across a geologic unit of interest; for example, a suspected mineralized area or a zone of alteration. The outcrop characteristics of the area covered by the chip sample was recorded. If a sample consisted of an individual highgraded rock or float material of unknown origin, this was also noted. Samples collected approximated 1-2 lb in weight.

A pulverized fraction of each crushed rock sample and a pulverized -80 mesh portion of each stream sediment sample collected was analyzed by standard atomic absorption methods for Cu, Pb, Zn, Co and Mn. These analyses were made by TSL Laboratories of Spokane, Washington. Results are noted in tables 1 and 2 and locations are shown on figure 4.

MINERALIZATION

The investigation was oriented to examine evidence of copper and cobalt mineralization associated with manganiferous beds and manganese nodules and reported copper and lead occurrences which are described from the pebble shale member of the Kongakut Formation.

The pebble shale member was located to both the north and south of Bathtub Ridge. Horizons of clay ironstone nodules were found and sam-

TABLE 1. - Geochemical analyses of stream sediment samples from the Kongakut River region, 1981

Map no.	Sample no.	Ag	Co	Cu	Mn	Mo	Pb	Zn
	AW19074	0.4	9	27	1045	2	12	120
	AW19075	---	21	41	1045	2	15	110
	AW19076	---	21	43	850	2	14	105
	AW19077	---	22	43	1100	2	14	105
	AW19078	---	28	48	1770	2	18	140
	AW19079	0.8	23	41	1240	2	15	92
	AW19080	0.3	7	27	53	3	13	53
	AW19138	---	18	44	1660	2	19	125
	AW19139	---	79	56	3250	3	28	225
	AW19149	1.1	31	39	2390	3	19	130
	AW19150	0.3	21	29	1435	<2	13	160
	AW19151	0.6	22	35	3450	<2	14	135
	AW19161	0.5	11	58	73	4	16	140
	AW19162	1.5	9	54	41	<2	15	115
	AW19163	1.0	29	39	1880	<2	18	145
	AW19164	1.0	18	39	610	2	14	105
	AW19165	2.8	48	87	1630	3	24	410
	AW19166	0.6	22	21	880	<2	16	125
	AW19167	0.5	19	24	900	<2	13	88
	AW19168	0.8	26	27	1920	<2	15	100
	AW19174	0.3	16	22	455	<2	15	155
	AW19175	0.7	25	30	500	<2	16	385
	AW19176	0.3	26	34	2400	<2	18	160

NOTE. - All units reported in parts per million.

Sample Locations 5663 - AW- Kongakut July 1981

FIGURE 3.
SAMPLE LOCATIONS MAP

TABLE 2. - Geochemical analyses of rock samples from the Kongakut River region, 1981

Map no.	Sample no.	Co	Cu	Mn	Pb	Zn	Sample Description
	AW19137	32	11	18700	27	59	Nodules from shales on south side of Drain Creek. Nodules form horizon in this shale.
	AW19140	41	27	14700	23	100	Torpedo-shaped nodule with blue cast.
	AW19141	44	43	1600	19	145	Disc-shaped nodule from shale unit.
	AW19142	15	18	515	22	27	Shale with white and yellow precipitate. Quite heavy. Iron and manganese staining.
	AW19143	34	19	12450	30	75	Nodule with visible pyrite. Blue manganese staining.
	AW19145	25	21	555	39	33	Pyrite nodule. Apparent metallic zoning.
	AW19146	28	14	1530	24	58	Shale from north side of Bathtub Ridge. Contains crystals of blue phosphates.
	AW19148	28	27	4280	21	84	Shale with quartz veinlets. Blue phosphates in the quartz.
	AW19171	25	41	470	18	135	Crumbly, brecciated black shale from locally folded/faulted zone.
	AW19172	60	47	365	170	57	Nodule. Iron-stained exterior with black earthy core.
	AW19173	23	17	950	125	48	Shale with small veinlets of quartz and yellow and white precipitate.

NOTE. - All units reported in parts per million.

pled from the saddle between Drain and Cottonwood Creeks at rock sample location AW19146 (fig. 4). These nodules have a rusty exterior, are somewhat heavy, and are extremely hard. Also typical of the pebble shale member is a blue phosphate mineral (vivianite) which was observed on some fracture surfaces and as small (<1mm) veinlets (AW19148).

The pebble shale member also forms a prominent bluff along the east side of Toilet Creek at sample location AW19140. The outcrop at this location is well exposed, and numerous manganiferous nodules were found and sampled. Here the nodules are firmly embedded in the shale. They are very abundant and occur in thin beds within the shale unit. Sizes vary from pebble to cobble. Typically they have a steel blue hue to them, probably due to coatings of manganese oxides. When struck with a hammer the nodules shed layers until a more competent center composed of the same material is reached. No sulfide mineralization was observed in these nodules, and manganese contents of the nodules did not exceed 1.5% with average value of 32 ppm Co (see table 2).

Several massive sulfide nodules characterized by concentric zoning of iron-sulfide rich layers (AW19145) were recovered from a room-sized cave in the shales about 100 ft above the base of the bluff. These, however, did not prove to contain any anomalous metal values of interest. Vivianite was again observed on some fracture surfaces within the shales of the cave (AW19170), where there was also evidence of moderate faulting, with quartz veining along fractures in the shale. [Any future workers should be cautioned that this cave is extremely hazardous and is prone to roof collapse without warning.] Samples AW19140, AW19143 and AW19148 from this outcrop indicate maximum grades in the range of 0.43% to 1.47% Mn. The interval sampled at this location is somewhat less than 100 ft in thickness, although the entire pebble shale member is not exposed here.

DISCUSSION

Investigation of the Drain Creek region has not revealed significant cobalt, copper, or manganese mineralization associated with the manganiferous beds reported to occur within the Kongakut Formation. Manganese content of the outcrops sampled was found to be considerably lower than previously estimated for the formation.

The USGS report of up to 5% Mn was made on similar rocks of the same stratigraphic horizon several miles to the east and on the opposite side of Bathtub Ridge. There are several possible explanations for the failure of the present investigation to locate mineralization comparable to that reported by the USGS. The first of these is the possibility that the mineralization is uneven and discontinuous. This is also suggested by Brosge (written communication) who states that Mn becomes richer as one moves eastward and by the stream sediment sample results (table 1) which trend to be slightly higher in Mn towards the east. [It is also noteworthy that manganese content of nodules can display as much as an eight-fold variation in a single location, as has been reported for fossil Jurassic Tethyan nodules from the Alps and Sicily (4).]

A very real possibility also exists that manganese was lost from the sediments during burial and compaction (4, 6). High manganese contents found in some marine nodules is often ascribed to migration of manganese through the sediments to the sediment-water interface to form nodules, while all, or a portion of the less mobile iron is retained as fixed sulfides deeper in the sediment. Indeed, under these conditions, it is expected that manganese would migrate out of the sediments once burial (and consequent reducing conditions) was initiated. While this might account for loss of manganese from the system, it is not especially convincing as an explanation of the low Co and Cu values in the area investigated in 1981, as compared to that reported by the USGS from the type-section. A third possibility, though not considered likely, is that the horizon exposed in the bluff along Toilet Creek is not stratigraphically equal to the manganiferous horizon reported from the type-section.

RECOMMENDATIONS

Further investigation of the area is not believed to be warranted at this time since no evidence of Cu or Co associations were found with the manganiferious horizon. It is suggested, however, that should future work be undertaken it involve: 1) a reexamination of the type locality of the Kongakut Formation on the north side of Bathtub Ridge, where the USGS reported "small amounts" of lead and copper within the manganifer ious pebble shale member, and 2) a closer examination of the exposures in the drainages on the south side of Bathtub Ridge both east and west of where Toilet Creek enters Drain Creek. Stratigraphic correlations must be a priority in any future investigations.

Note: In the future, it is strongly recommended that suspected "manganese nodules" or "clay ironstone" nodules, etc. have geochemical analyses performed for Fe (and possibly Ba) in addition to Mn and whatever other elements are of interest. The reasoning behind this is that the literature tends to classify and describe manganese nodules in terms of Mn/Fe ratios. It is possible that a relationship exists between these ratios and the presence or absence of the "trace elements" such as Co and Cu in manganese nodules.

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